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Do Browser Cookies Really Affect Online Airline Ticket Prices?

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Abstract

Many travel websites recommend that consumers clear their cookies before buying an airline ticket in order to get better prices. Today the idea that browser cookies might influence the price of an airline ticket is widespread. Charging different prices to different consumers for the same product where those differences in price do not reflect differences in cost is called price discrimination. Internet technology has made it possible for airlines to price discriminate between their consumers using browser cookies. But do they really charge different prices to consumers with cookies on their computers showing that they have already visited the website? Or is it an urban myth? The aim of this study is to find evidence on the domestic U.S. airline market. Prices were collected on 41 routes flown by three of the leading U.S. airlines: American Airlines, Delta Air Lines, and United Air Lines. Results suggest that browser cookies do not affect online airline ticket prices.

1. Introduction

Many travel websites recommend that consumers clear their cookies before buying an airline ticket in order to get better prices. For example, on *Budgettravel.com,* O'Neill states that, "Travel sites […] have used [cookies] to avoid showing you the same price every time you visit. Delete your cookies and they'll treat you like a new customer."[16] *Wikihow.com* advises to "Clear out your cache and cookies in between airline searches, especially on different days or weeks. Otherwise, old prices will sometimes display in lieu of new ones, and you may miss out on the best price."[11] On *Gadling.com*, Blasko mentions that "To make sure you're getting the best prices when you book air travel online, be sure to clear your web browser's cookies and cache. This will make it appear as if it's your first time visiting these sites, and you're likely to see much better prices for your next flight!"[4] The idea that browser cookies might influence the price of an airline ticket bought online is widespread. In theory it is possible for airlines to use browser cookies to price discriminate. But do airlines really do it? Or is it an urban myth?

In theory browser cookies could be used by airlines to price discriminate for two reasons. First, the airline industry has a market structure favorable to price discrimination.[9] Second, airlines have already shown an eagerness to price discriminate using many other strategies.[5,18,20] We would therefore expect airlines to consider new strategies to price discriminate. The research aims to find evidence that browser cookies influence ticket prices on domestic U.S. flights. This paper is divided into five sections. The first discusses price discrimination theory and price discrimination in the airline industry. The second explains how Internet technology can be used to facilitate price discrimination. The third provides background information on browser cookies in order to better understand how they can be used by firms. The fourth section describes the method used to test the hypothesis and the last presents and discusses the results.

2. The Airline Industry: a Favorable Market for Price Discrimination

Price discrimination is one of the most common pricing strategies used by firms to maximize profit.[22] It is defined as the practice of charging different prices to different consumers for the same product where those differences in price do not reflect differences in cost. It is well known that most passengers on individual flights buy their tickets at different prices.[20] According to Helve, the high level of price dispersion in ticket prices is the result of price discrimination, uncertain demand, and high fixed cost.[10] The importance of each of those three components explaining price dispersion is uncertain; but he notes that price discrimination appears to play the greatest role.[10]

2.1. Airlines Meet The Three Conditions Needed To Price Discriminate

Three conditions must be met for firms to practice price discrimination.[22] The first is that firms must have *market power*, that is, they must be price setters.[22] A firm has market power when it doesn't have to worry about other firms charging lower prices if it decides to charge higher prices. In a competitive market we expect every firm to charge the same price, such that price equals marginal cost.[9] It implies that price discrimination requires a non-competitive market since firms have no market power and are price takers in competitive markets.[9] Steen and Sørgard note that "In the airline industry we do not observe price equal to marginal cost."[20] Therefore, airlines are price setters.

The second condition is that firms must be able to *prevent low-price consumers from reselling to higher-price consumers.*[22] If a firm cannot prevent low-price consumers from reselling to higher-price consumers, we would eventually expect low-price consumers to engage in arbitrage. They would resell their tickets at prices slightly higher than what they paid but still undercutting airline prices charged to higher- price consumers. Airlines are able to prevent resell by selling non transferrable tickets that include the traveler's name and ID.

The third condition is that firms must be able *to separate consumers according to their willingness to pay*.[22] The ultimate objective of price discrimination is to maximize profit by charging consumers a price as close as possible to the maximum price they would be willing to pay. The airline industry is often used as an example of ways firms can differentiate between consumers with different willingness to pay. For instance, airlines can differentiate between two types of travelers with different price-elasticity of demand: business and leisure travelers.[9] Demand elasticity is a measure of the consumer's responsiveness to changes in price. Higher prices can be charged to consumers with lower price-elasticity of demand since an increase in price is less likely to influence their willingness to buy. According to Gaggero and Piga, because business travelers are on tighter schedule and find it difficult to substitute travel time and mode of transportation, their demand is less price elastic than leisure travelers.[8] Airlines can differentiate between business and leisure travelers according to destinations (business versus vacation cities), ticket restrictions (refundable and flexible; economic, business, and first class), number of days the tickets are purchased before departure, whether or not the trip includes a Saturday night stay-over, and holiday periods.[5,18,20]

2.2. A Detailed Look At Price Discrimination Strategies Used By Airlines

Since the airline industry satisfies the three conditions needed to price discriminate, we can give a closer look at some of the strategies used by airlines. There are three types of price discrimination: *personal*, *product*, and *group discrimination*.

2.2.1 personal – or first degree

Price discrimination is when sellers charge a different price for each unit, based on each consumer's willingness to pay.[20] Because it is difficult to estimate each consumer's willingness to pay, personal discrimination is the most complicated type to practice and therefore the least common. However, Internet technology has the potential to facilitate personal price discrimination through means like the use of cookies.[21]

2.2.2 product – or second degree

Price discrimination differs from personal and group discrimination as the differentiation intends to separate products, not consumers.[14] Consumers separate themselves as a result of the differentiation of the products. Product discrimination is practiced by airlines all the time. One of the most common strategies is *versioning*. It consists of

offering different versions of a ticket for the same flight by putting restrictions on tickets.[20] Consumers often have the option to get a refundable and/or flexible ticket and they can also choose between economy, business or first-class. Airlines charge a lower price for tickets with the most restrictions. Another commonly used strategy in this industry is *inter-temporal price discrimination* (IPD). According to Bergantino and Capozza, IPD consists of charging different fares to different consumers according to the number of days a ticket is purchased before departure.[3] In their study on IPD, Bergantino and Capozza found that prices are changing according to the J-curve effect: early-bookers pay moderately higher prices compared to middle-bookers, whereas late-bookers pay the highest fares.[3] Furthermore, airlines also discriminate depending on the day of the week. Puller and Taylor call it *day-of-week price discrimination.*[18] They found that fares were 5% lower on the weekend than on the other days of the week.[18] While versioning intend to sort consumers according to their general willingness to pay, inter-temporal and day-of-the-week price discrimination are strategies used to separate business and leisure consumers based on their search behavior.

2.2.3 group – or third degree

Price discrimination is when a firm can differentiate between groups of buyers and take advantage of their different willingness to pay by charging different prices.[14] According to Steen and Sørgard, *discount to large consumers* and *frequent flyer programs* are two common practices of group discrimination in the airline industry.[20] An example of discount to large consumers is when firms have a contract with airlines so that the firms' employees get lower price rates on their tickets.[19] Frequent flyer programs are habitual in the airline industry. Members of those programs can earn points that lead them to get a free baggage waiver or often a free ticket.[20]

3. Internet Technology to Facilitate Personal Price Discrimination

Recent Internet developments have generated new opportunities for firms to price discriminate.[15] As mentioned earlier, personal price discrimination is the hardest for a firm to achieve since it requires personal information from consumers. Ulph and Vulkan explain that consumer-specific information is usually complicated and expensive to get.[21] However, the development of e-commerce has made it easier in recent years and firms have been taking advantage of it. According to Ulph and Vulkan, "an enormous amount of consumer-specific data has been collected by retailers and marketing companies."[21] The Internet now offers a means for firms to collect consumer-specific data and therefore facilitate personal price discrimination. By gaining private information, firms may be able to estimate more accurately each consumer's willingness to pay. In turn, they can individually customize their website pages and online catalogues.[21] In other words, firms can offer products that consumers want at prices that they are willing to pay.

According to Koch and Cebula, browser cookies are the easiest way for firms to legally obtain information about consumers.[13] Cookies provide information about users' activity on specific websites.[6] Although consumer-specific information can be collected via other means, such as intelligent agents for data mining, this paper will focus on browser cookies since the goal of the study is to find evidence that airlines use cookies to charge different prices to different consumers for the same ticket.

Although travel websites state that consumers will be charged higher prices if they don't clear their cookies before buying an airline ticket online, it could be equally true that they charge lower prices. While numerous visits show that a consumer is interested in a flight or in traveling at a specific date, it might also indicate that a consumer has a very price-elastic demand and is looking for the best prices. On one hand, considering consumers' high interest in the flight, the economic theory would suggest that a higher price should be charged since consumers are more likely to buy it. On the other hand, considering consumers' high price elasticity of demand, a lower price should be charged. Although the study was motivated by the statement made by travel websites that higher prices are charged, it is equally interesting to investigate whether airlines use cookies to price discriminate in the interest or against consumers.

4. Browser Cookies as a Means for Personal Price Discrimination

In order to understand how browser cookies could be used by airlines to price discriminate their consumers, it is first necessary to understand what cookies are, how they work, and what they are used for. According to Marshall Brain, holder of a Master's degree in computer science from NC State University, a cookie is a piece of text that a web server can store on a user's hard disk.[6] Cookies allow a website to store information on a user's machine and later retrieve it. Brain further explains that, although there is no limit to the amount of information stored by a website, most of them will simply store a user ID number.[6]

When you type the web address (URL) of a website, your browser does two things: it sends a request for the website page and it looks into your machine to find a cookie file from this website. Assuming that the website uses cookies, your hard disk will contain a cookie file if you have already visited the website. Once the file is found, your browser will send the information contained in this file to the server along with the page request. However, if you visit the website for the first time, no cookie file will be found. Thus, only the page request is sent to the server. For websites using cookies, although no information is sent, it still indicates that you have never visited the website before. A new cookie file is then created with a new ID and any information that the website would like to store. Brain explains that once on your computer, cookies don't do very much.[6] In fact, a website can only use information that it stored itself: the information stored by other websites is inaccessible.[6]

Even though users do not directly see this process happening, they have some control over it. On computers, users can select an option in order to choose to accept or deny cookies every time they are sent. Cookies can also be removed from a computer at any time. Those two options were used in this research in order to gather prices both from a computer collecting cookies and from a computer without cookies.

Brain provides three major reasons why browser cookies are used by firms.[6] First, it allows them to accurately determining how many readers visit the site and whether those visitors are new or repeated.[6] Second, firms can store user preferences and customize their site differently for each visitor.[6] Third, e-commerce firms can use options to make shopping online more convenient for the visitors by remembering what had been in their cart and what they bought.[6] Thus, cookies can potentially benefit both consumers and firms. The reason why cookies make targeting much more precise for firms is that the site can track not only your purchases, but also the pages that you read, the ads you click on, etc.[6]

By providing information about how many times a visitor has been an airline website and has checked prices for specific flights, cookies might be used to estimate visitors' willingness to pay. As mentioned earlier, airlines separate between business and leisure travelers to price discriminate on the basis of their different price-elasticity of demand. We expect travelers with higher price elasticity of demand to visit airline websites more often. For instance, we expect business travelers to buy their ticket after visiting the website no more than two or three times. The main reason is that they have very few substitutes due to their lack of flexibility and therefore they don't need to compare prices. On the other hand, leisure travelers usually have a more price-elastic demand because their time schedule is more flexible and they are more open to explore different destinations.[8] It is more likely that leisure travelers will check a greater number of prices for different dates and destinations before buying their ticket. Such comparisons are likely to require several visits on a same airline website for similar flights. Furthermore, most travelers are aware of the high fluctuation of airline ticket prices.[20] It is then reasonable to think that travelers with high price elasticity of demand are more likely to visit airline websites more regularly in order to try to get the best prices. The number of visit on an airline website can therefore be an indicator of a consumer's price elasticity of demand.

5. Methodology

The empirical strategy is to create a data set of airline ticket prices. The data collection period took place from January 27, 2014 to March 19, 2014. I gathered prices every day for the first three weeks, and, then, every five days until the day of departure. I collected prices quoted on the official websites of three of the leading U.S. airlines: American Airlines, Delta Air Lines, and United Air Lines.[7] For the 41 routes making up the sample, I collected prices from two different computers: my own computer and one of the public computers at the University of North Carolina Asheville. On my computer, I cleared cookies on the first day, before starting the data collection. Then, I set my computer so that it would collect cookies and I checked that all three airline websites were leaving cookies after each visit. This means that the Airlines could tell that I visited the website before and that I have been looking

at the same flights several times. On the UNC Asheville public computer, I cleared cookies before looking at the price of each ticket, between each search. In this case, I appeared as a new consumer every time I visited the website. We can therefore expect prices on the two computers to be different if the airlines use cookies to price discriminate.

I used a sample from of a set of city pairs that had been used in previous studies on airline industry pricing. Specifically, the set of city pairs that had been used by Puller, Sengupta, and Wiggins in "Testing Theories of Scarcity Pricing in the Airline Industry," as well as by Puller and Taylor in "Price Discrimination by Day-of-Week of Purchase: Evidence from the U.S. Airline Industry."[17,18] There are two main reasons why I used a sample from this specific set. First, Puller and Taylor found that price discrimination was practiced on these routes.[18] As we are looking for evidence of price discrimination, it is important to know that airlines have the ability to price discriminate on the routes composing the sample. The second reason is that the categorization of "mixed" versus "leisure" routes done by Puller and Taylor was beneficial.[18] We expect price discrimination to be more feasible on "mixed" routes for reasons that will be explained below. The main difference between the two previous studies and this one is that they both used data from a census to get the actual price paid, while I initiated ticket purchases to get price quotes.[18]

The original set of city pairs is made up of 85 routes representing a stratified sample of the largest routes for six of the U.S. largest carriers: American, Delta, United, Continental, Northwest, and US Airways.[18] In this case, a stratified sample means that it includes flights from varied market structures: level of competition, demand, type of travelers, etc.[18] My analysis is restricted to the 41 flights served by three of these carriers: American (14 flights), Delta (13 flights), and United (14 flights).[1] A list of the routes is shown in Table 1 on page 6. All 41 routes are round trip and have non-stop flights with departure on the morning (between 8 a.m. and 10 a.m.) and return late afternoon (between 4p.m. and 6 p.m.). For routes that did not offer flights during those time slots, I picked the flight with the time closest to that slot. When more than one flight was offered in the time slot, I randomly picked one, disregarding if it was the most or least expensive. Using this method, the sample included some of the most expensive and some of the least expensive tickets offered on a given day. Once I chose the flights for each route on the first day, I only collected prices for those particular flights during the entire collection period.

I collected prices for tickets with the most restrictions: non-refundable and non-flexible tickets in economic class. In some cases, only refundable tickets or first class tickets were available; I would then use the price of those tickets. Furthermore, toward the end of the collection period, as it became closer to the departure day, a few of the flights sampled no longer had seat available. In this case, no price was collected. Although choosing tickets with the most restrictions might have affected the results by already separating consumers according to their willingness pay, Puller and Taylor found evidence of day-of-the-week price discrimination among the most restricted tickets.[18] Thus, a previous study showed that price discrimination had been practiced on the sample of tickets used in this research.

All 41 routes have a departure flight of March 20, 2014, and a return flight of March 23, 2014. Since the ability to separate between consumers with different price elasticities of demand is the key to price discrimination in the airline industry, dates were chosen so that flight attendance would be likely to have a good mix of both business and leisure travelers. First, a four-day trip can be for business as well as for leisure purposes. Second, most students have a week off for spring break in March. Depending on the schools, Spring break 2014 was between February 16th and April 17th.[12] We can therefore expect some students and families with students to travel from March 20th to March 23rd.

Using the categorization done by Puller and Taylor, each route is defined as a "leisure" or "mixed" route.[18] A "leisure" route is a route for which most travelers are likely to be leisure travelers.[18] A "mixed" route is a route for which travelers are likely to be both leisure and business travelers.[18] We expect price discrimination to be practiced on "mixed" routes more than "leisure" routes, since they provide a greater mix with consumers with different price elasticity of demand.

Puller and Taylor used two methods to classify routes as "leisure" and "mixed."[18] The first method uses a tourism index which equals the ratio of 2004 accommodations income to total personal income for the Metropolitan Area of the destination airport.[18] The second method uses the business travel index of domestic airline travel created by Borenstein in 2010.[18] A route is classified as "leisure" if it either has a tourism index above the 80th percentile or a business index below the 20th percentile of the routes from the original set used in the studies done by Taylor and Puller, and Puller, Sengupta, and Wiggins.[18] The "leisure" routes in the present study are the ones with the following destinations: Denver, Fort Lauderdale, Las Vegas, Miami, Orlando, Phoenix, San Diego, Seattle, and Tampa. The other routes are classified as "mixed." This means that eight of the 41 routes are characterized as "leisure" routes, and 31 are characterized as "mixed" routes.

Table 1. Routes included in the analysis by origin and destination city (airport code)

American Airlines
Las Vegas (LAS) - Dallas-Ft Worth (DFW)
Los Angeles Intl (LAX) - Dallas-Ft Worth (DFW)
Los Angeles (LAX) – New York-JFK (JFK)
Chicago-O'Hare (ORD) – New York-La Guardia (LGA)
St. Louis (STL) – Dallas-Ft Worth (DFW)
Phoenix (PHX) – Dallas-Ft Worth (DFW)
Los Angeles Intl (LAX) – Chicago-O'Hare (ORD)
Dallas-Ft Worth (DFW) – Denver (DEN)
Dallas-Ft Worth (DFW) – Orange County (SNA)
Chicago-O'Hare (ORD) – Dallas-Ft Worth (DFW)
New York-La Guardia (LGA) – Miami (MIA)
Chicago-O'Hare (ORD) – St. Louis (STL)
Dallas-Ft Worth (DFW) – Orlando (MCO)
Miami (MIA) – New York-JFK (JFK)
Delta Air Lines
Dallas-Ft Worth (DFW) – Atlanta (ATL)
Orlando (MCO) – Atlanta (ATL)
Los Angeles Intl (LAX) – Atlanta (ATL)
Los Angeles (LAS) – Atlanta (ATL)
New York-La Guardia (LGA) – Atlanta (ATL)
Cincinnati (CVG) – Atlanta (ATL)
Atlanta (ATL) – Miami (MIA)
Tampa (TPA) – Atlanta (ATL)
Cincinnati (CVG) – New York-La Guardia (LGA)
Atlanta (ATL) – Philadelphia (PHL)
Atlanta (ATL) – Fort Lauderdale (FLL)
Newark (EWR) – Atlanta (ATL)
Boston (BOS) - Atlanta (ATL)
United Air Lines
Los Angeles Intl (LAX) – Denver (DEN)
Los Angeles Intl (LAX) – Chicago-O'Hare (ORD)
San Francisco (SFO) – San Diego (SAN)
Los Angeles (LAS) – Chicago-O'Hare (ORD)
Denver (DEN) – Chicago-O'Hare (ORD)
Washington-Dulles (IAD) – San Francisco (SFO)
Washington-Dulles (IAD) - Chicago-O'Hare (ORD)
Chicago-O'Hare (ORD) – San Francisco (SFO)
Los Angeles (LAS) – Denver (DEN)
San Francisco (SFO) – Los Angeles Intl (LAX)
Ontario (ONT) – Denver (DEN)
Seattle (SEA) – Chicago (ORD)
Chicago-O'Hare (ORD) – New York-La Guardia (LGA)
Portland (PDX) – San Francisco (SFO)

6. Results and Discussion

The sample tested in this study did not provide any evidence that American Airlines, Delta Air Lines, or United Air Lines, practice price discrimination based on browser cookies. In fact, results strongly suggest that airlines do not use cookies to price discriminate. Table 2 reproduces a very small sample of the data set[2] (6 prices among 2,296 collected). It is a representative sample for every set of prices (price from a computer with cookies and without cookie) collected for every airline on every route. The table presents the prices collected on three routes on a different day, each by a different airline. Note that in the data set, for each route on a given day, the price quoted on the computer with cookies was always the same as the price on the computer without cookie.

Table 2. Sample of the data set

Date	Airline	Route	Flight number (Departure-Return)	Price with cookies	Price without cookie
2/1/2014	American Airlines	LAS – DFW	1499 - 1067	$332	$332
2/16/2014	Delta Air Lines	LAX – ATL	80 - 1076	$680	$680
3/7/2014	United Air Lines	ORD – SFO	761 - 1736	$706	$706

Although the sample tested didn't provide any evidence, it is possible that price discrimination based on cookies is used in other cases. For example, future research could repeat the method used in this study to test different samples: other city pairs, other airlines, other dates, and other type of tickets – different ticket restrictions – could be used. More specifically, it would interesting to look at statistics providing information about when business and leisure travelers are more likely to fly and pick a date with a high attendance of both types of travelers. Finding statistics showing when business and leisure travelers usually book their tickets might be used to figure out a good time to collect data. Price discrimination would be more likely to be practiced during a time when both business and leisure travelers book tickets.

In addition to look at different samples, a similar method could also be considered to test whether cookies are used to price discriminate by online travel agencies such as Kayak, Skyscanner or Expedia. Such websites are convenient for consumers since they can easily compare prices between different airlines. However, in the article "Cheapest Airfares Might Be on Airlines' Own Websites" from the Associated Press published on *DailyFinance* website, it is mentioned that airlines might be charging lower prices than online travel agencies.[1] Since they may charge different prices, even though airlines might not be using cookies to discriminate, travel agencies may do so.

Although this study focused on browser cookies since travel websites assert that they influence online ticket prices, it was mentioned earlier that specific intelligent agents for data mining also provide consumer-specific information.[21] Ulph and Vulkan state that most consumer-specific information is actually collected through those agents.[21] Intelligent agents for data mining are programs that can estimate buyer preferences, valuations and product tastes by combining consumer purchase histories with individual and site demographics.[2] It would be interesting to expand this research by testing whether airlines use personal price discrimination based this type of intelligent agents.

Finally, a more theoretical direction for future research could be to investigate personal price discrimination theory on e-commerce in general, not just in the airline industry. It is known that cookies and intelligent agents are frequently used to personalized websites,[19] but it would be interesting to explore how the different market structures of e-commerce influence the use of Internet technology to practice personal price discrimination. For instance, it might be the case that airlines are not using cookies to price discriminate because it is not a profitable pricing strategy in this market. Future research could focus on personal price discrimination theory on e-commerce and aim at describing conditions and market structures for which such pricing strategy is likely to be favorable.

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9. Endnotes

[1] Although my sample is restricted to three of the six airlines, we still expect to have a stratified sample since it includes all flights for each of the three airlines.
[2] Full data set available on request.